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TOOL AND MACHINE MAINTENANCE*

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1. MAINTENANCE OF BLADES FOR WOODWORKING

Woodworking tools play a very significant part in mechanical processing of wood; the profitability of a number of woodworking plants will depend upon them. Tools are considered well prepared and suitable when their life is long enough and their durability adequate. Proper sharpening procedures and use will certainly have decisive influence upon the tools' life; the quality of steel they are made of will, on the other hand, play a part in blades' durability, and optimum performance is only attained with adequately sharpened and properly used tools.

The technology used for sharpening saw blades and knives has made a big step forward in the last ten years; electronics has come to play a significant role in this field. The use of computer-supported machines provides an enormous advantage when compared with those used a few decades ago, and this implies both manufacturing accuracy and quality of sharpening and grinding.

2. MATERIALS USED IN THE MANUFACTURING OF BLADES

Saw blades are made from chrome-vanadium steel with a limited (0.6%) carbon content, with addition of other elements, such as silicon, nickel. manganese, and some alloys. High-alloy steel of varying quality grades is used for veneer knives, planer knives, surface scrapers, borers, and other sophisticated cutters. Blades and knives for laminates and other hard materials are plated with "Widia" (an alloy of great hardness, equal to that of carbide). The maintenance of blades made from carbide-alloys is extremely demanding and costly, which is one of the reasons for their substitution by synthetic diamond. The sharpening and other maintenance procedures are adjusted to suit the specific materials from which blades or knives are made.

3. SHARPENING MACHINES AND EQUIPMENT

Sharpening devices of varying forms and commodities are used for blades and knives. The composition of sharpening devices or grinding wheels may differ to a large extent. Ceramic grinding wheels or those

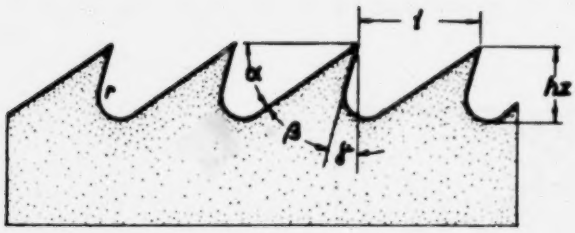
made of corundum and silicon grains are used for the sharpening of medium- and high-alloy steels; the size of grains depends on desired sharpening procedures. Usually wheels are used with grain of mesh size ranging from 40 to 120. The hardness of the grinding wheels is of paramount importance in the sharpening of tools. The following rule of thumb is applied: the harder the steel to be sharpened, the softer is the grinding wheel used. The hardness of grinding and sharpening wheels is designated with letters: I, J, K. H are used for low-toughness, L and M for medium-toughness and P, R and subsequent letters for high-toughness grinding and sharpening wheels. The porosity of grinding wheels also plays its part in the sharpening of tools: the larger the surface to sharpen the more porous is the sharpening device used.

Pre-grinding is recommended for blades plated with "Widia" for this purpose a coarse-grain (e.g. D 150) grinding wheel is first used, followed by a D 30 grinding wheel. Generally speaking, diamond sharpening and/or grinding devices are used for the hardness similar to that of carbide; exceptionally, grinding wheels with silicon grains or borazon plates may be used for very rough grinding.

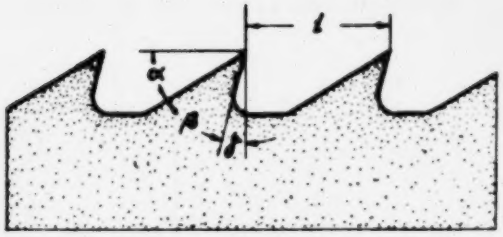
During sharpening the tip of the blade will become hot, thus less tough, and the result may be a very serious defect. It is possible to avoid this risk by using a coolant in the course of sharpening. At the same time the sharpening device must be kept clean and chip removal provided. As the abrasive wheel becomes clogged up, the surface is trued using a diamond-ended "pencil" that is traversed horizontally across it. (This way contours can also be developed on abrasive wheels.)

4. BAND-SAW BLADES

The tips of the saw blade's teeth are bent to the left and to the right by 1/3rd of the blade's thickness (spring-set). Compression procedure is also used (swage-set). If blade teeth tips are swaged their surface should be hardened by a high-frequency procedure. In this manner durability of the blades can be increased by about 50 per cent.



The geometry of teeth of band saw blades used for hardwood species with a fast feed.



The geometry of teeth of band saw blades used for softwood species.

The geometry of the tips of teeth of band-saw blades is as follows:

Distance between teeth (t):	22 - 28 mm
Height of teeth (hz):	1 t
Radius of the gullet between teeth (r):	6 - 8 mm
Rake angle (α):	20 - 31°
Bevel angle (γ):	14 - 18°
Cutting angle (β):	45 - 52°

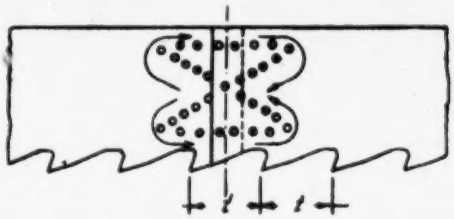
The geometry depends upon the wood species, condition of wood (fresh or dried), rate of feed, etc.

5. SHARPENING OF WIDE BAND-SAW BLADES

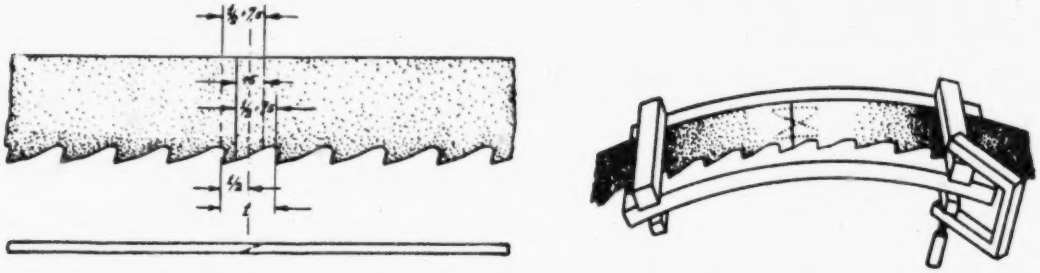
The width of the blade depends on band wheel design. At any time of operation the tips of the teeth must protrude over the rim of the wheels by 10 to 15 mm. Band-saw wheels must be convex if we want the blade to fit perfectly. Blade thickness will depend on its width, and is usually 1/1,000th of the wheel's diameter; if the wheel diameter is large, e.g. 1,800 mm, the blade thickness is usually reduced by 0.1 mm.

A stage in the band-saw blade preparation is the brazing of the blade. The blades are supplied in coils of 50 m; different brazing or welding procedures are used, from scarf jointing and butt joint welding to spot welding.

In certain countries steel is bought in rolls and then the teeth are punched out after the desired length of blade has been cut from the foil.

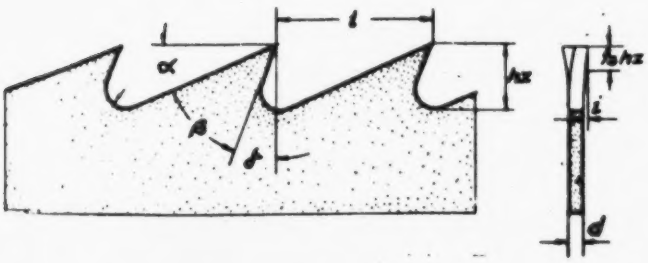


The weld is hammered with a cross-headed or a point-headed hammer to relieve stresses in welding.

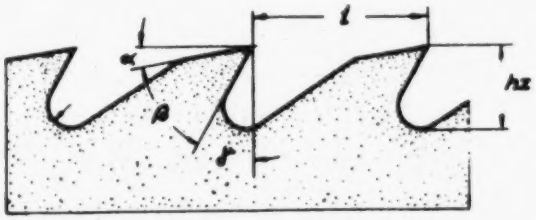


Blade welding and smoothening

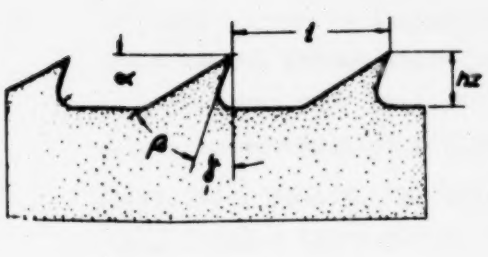
Each of the above welding procedures can only be performed with adequate equipment.



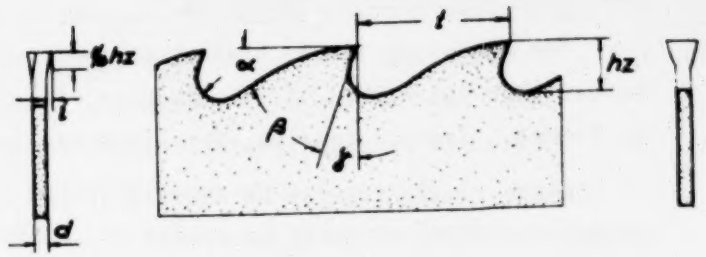
Close-pitch saw blade for softwood species.



Close-pitch front-bevel saw blade for softwood species.

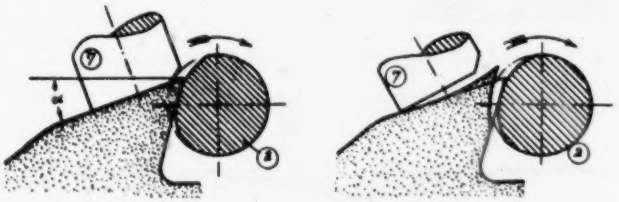


Wide-pitch saw blade for very soft and freshly felled logs.



"American" pitch for hardwood species; teeth tips are compressed, and, if necessary, tipped with stellite.

The geometry, i.e. shape and size, of the tips of teeth will depend on species of wood, its condition, thickness of the blade, etc. The distance between teeth points (pitch) (t) ranges between 30 and 60 mm, and the height of teeth (hz) is 1/3rd of pitch. The angle (γ) of the teeth is very significant (γ = 18 to 25°), particularly when tips of the teeth are swaged. The cutting angle (β) depends on the wood's hardness (β = 45 to 55). The rake angle (α) and the bevel are also determined by blade manufacturers, taking into account wood species and other parameters.



CORRECT WRONG

Swaging (compression) of the tips of teeth

The finish of a sawn surface will be smooth when blade teeth are swaged; tips of teeth may also be improved with stellite, which will result in far longer durability of band-saw blades when tropical species are sawn, and the blade will thus wander much less than without this additional treatment.

(a) Band-saw blades' tensioning

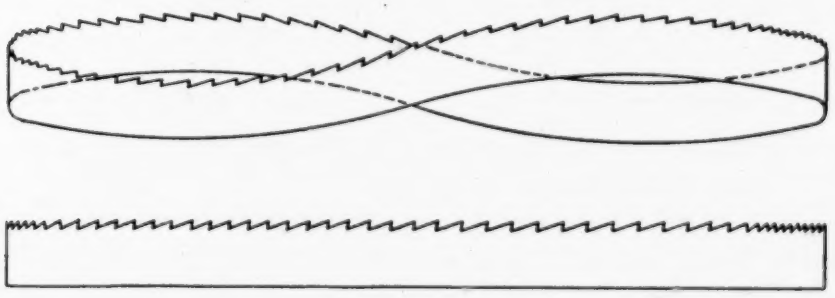
The wandering of the blade back and forth during sawing can be prevented when the middle of the blade is elongated, i.e. when tensioning is performed. Special tensioning rollers are used for this purpose.

Blade tensioning can be checked if the blade is put onto a levelling table, the blade slightly bent, and a ruler is put onto the blade's back side at an angle of 90°. A bulge will then be noticeable under the ruler. The same is done when the blade is bent in the opposite direction. The gap must be as wide as the convexity of the band wheel.

Some elongation is present along the entire length of the blade, as well as its width, except at its back side; it is therefore recommended for wide band-saw blades to be rolled in such a way that there is a slight bulge or curve on its back side. The curve should be 0.5 to 1.0 mm for every 1.5 m length. For narrow and thinner blades the back side of the blade should be completely flat. These should have no curve or bulge whatsoever.

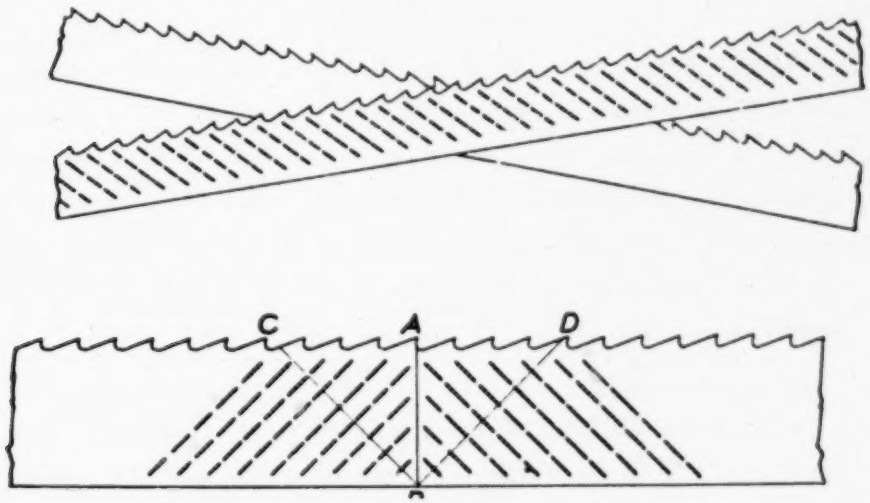
The importance of the tensioning of band-saw blades is quite obvious if they are to oeprate properly. When the tension is inadequate the blade will wander back and forth, develop cracks, vibrate or even break.

(b) Band-saw blade bending (Number 8 form)



Band-saw blade bending in the form of number 8.

The bending of a band-saw blade is a grave fault caused by its improper use or by inadequate welding. The bending in the form of a number 8 may be observed when the blade is put onto a flat surface (e.g. ground) and it will bend in a number 8 form on its own. This defect may develop in a new blade due to its overloading, i.e. when blows occur during the sawing. The defect may be corrected by hammering it with a cross-shaped hammer the weight of which is 1 kilo. Both sides of the blade must be hammered under an angle of 45°.



Repairing blade bending by hammering
(with a cross-shaped hammer).

(c) Cracks and other defects of saw blades

Saw blade cracking is not a rate defect in band-saws; the causes are manifold:

(i) Overtensioned blade in the machine: In this case cracks develop on the front or the back side of the blade, i.e. between teeth. Average value of tension (tensile stress) is usually 5 to 7 tons for a 140 to 200 mm wide and 1.2 to 1.45 mm thick blade.

(ii) When the gullet between 2 teeth is very sharp, and burnt due to rough sharpening with a grinding wheel cracks will also develop; great care must be taken therefore to keep sharpened surfaces smooth and not burnt. After rough sharpening, a soft grinding wheel must additionally be used to avoid this defect. The gullet between 2 teeth must also have a radius of at least 4 mm, which can be obtained and maintained by forming the profile of the grinding wheel.

(iii) Excessive, insufficient, as well as unbalanced or non-proportionate internal stress, may also result in cracks.

(iv) Excessive pitch in such saw blades that are used for the sawing of hardwood, particularly in the winter time. Before a winter begins it is necessary to procure blades with a small pitch, which is suitable for the sawing of frozen wood, when a balanced rate of sawing and rate of feed must be supported by a small-pitch blade. This problem often causes enormous material and capacity losses in our sawmills.

(v) Inadequate teeth angles: The tooth bevel plays a very significant role. When the angle of the tooth proves to be too small the risk develops that the blade will break due to overload; if the angle is too large, however, cracks will develop in the surface between the teeth. This defect becomes a problem when individual work pieces to be sawn are very different from each other, and when a number of blades of differing shapes are sharpened with one sharpening machine only.

(vi) Cleanliness of the blade and band wheel: Prior to all sharpening procedures the blade must be cleaned of all stains; the cleanliness of the woodworking machine, i.e. the band-saw itself, should also be paid atention to. All sawdust must be collected by exhausting devices; when sawdust is left on the band wheel surfaces, cracking of the saw blade will result.

(vii) The positioning of band wheels on the sawing machine is also very important: The wheels must be assembled in a strict vertical position one above the other, which is significant at the time when the bearings are changed and when other major maintenance procedures are carried out. The fixing and ability of the guides is also to be emphasized in this connexion. The weight of the log feed carriage, and the precision when fixing the carriage rails, also have an impact upon the new blade; the angle between the rails and the face of the band wheels must always be 90°.

(viii) Incorrect and unequal swaging or spring setting also causes cracks.

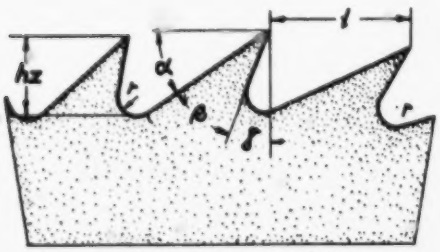
6. CIRCULAR SAWS FOR EDGING AND TRIMMING

Circular saws for edging and trimming are used in a sawmill in which sawn wood is partially processed into elements of specific dimensions (broadleaved species) or into boards (coniferous species) that must be trimmed.

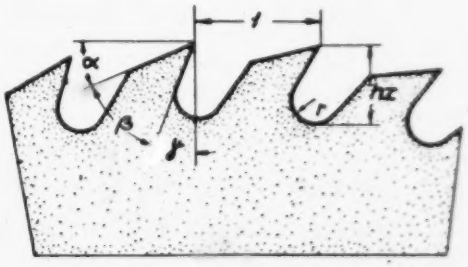
(a) Thickness of blades

In new sawmills usually usually only circular saws are used for coarse sawing; hence their larger thickness than that of other circular saws. The thickness of blades used for coarse sawing ranges from 2.5 to 3.5 mm.

The shape of teeth of a circular saw for longitudinal cutting is shown hereunder:

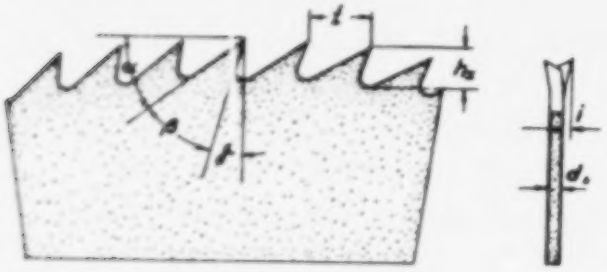


Close-pitch circular saw for longitudinal cutting of softwood species.

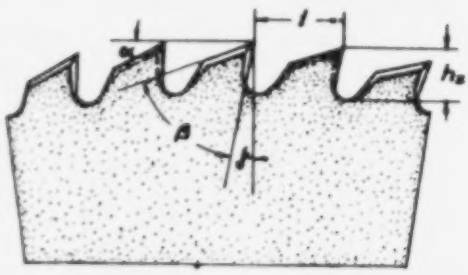


Close-pitch front-bevel circular saw for rough cutting of softwood and hardwood species.

The corresponding shape of teeth of a circular saw for cross-cutting is:



Close-pitch circular saw for cross-cutting.



Close-pitch circular saw for hardwood cross-cutting.

(b) Shape of teeth

For coarse sawing usually saws with sharp teeth-angles are used (particularly for softwood), or those with a very close pitch (particularly for hardwood).

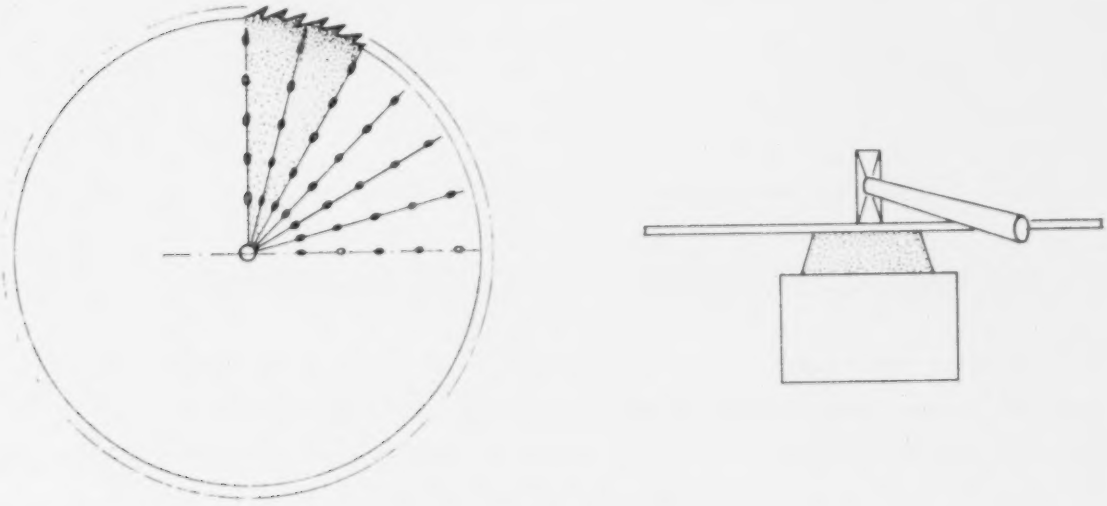
In all cases the tooth cutting angles range from 45 to 55°, the angle being smaller for softwood species, and larger for hardwood. The tooth bevel (δ) varies between 20° and 30° for circular saws used in sawmills. The angle is smaller in circular saws used for facing and larger in those used for longitudinal cutting (ripping). Transverse sharpening of teeth is not used in this type of circular saw since it would reduce the durability of the blades. An exception to the above rule is made cor circular saw blades used for the cutting of boards to dimensions. When transverse teeth sharpening is used, the angle should be 10°.

(c) Pitch and height of teeth

The pitch of circular saws used for coarse cutting is 30 to 45 mm; the pitch is the largest in circular saw blades used for ripping of softwood, and smaller in the blades used for the cross-cutting of hardwood, obviously in relation to the hardness of wood: the harder the wood species and the larger the load to which the blade is exposed, the smaller the pitch.

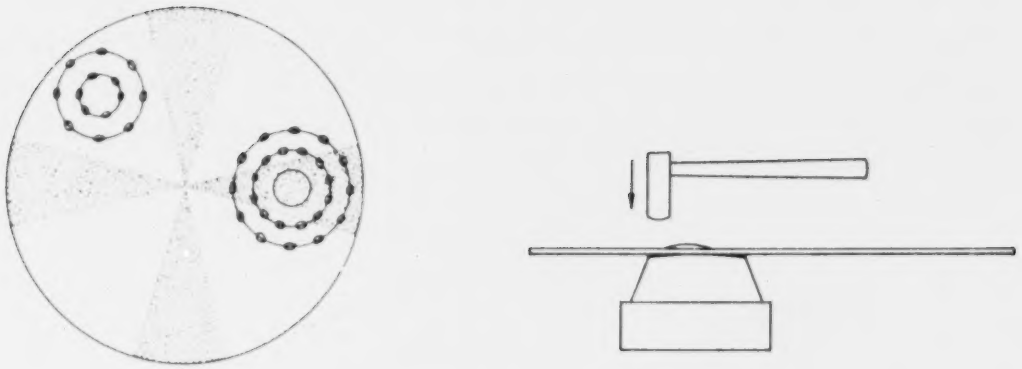
(d) Durability of circular saw blades

Circular saw blades used for ripping are usually changed at intervals of 6 to 8 hours, and the cross-cutting saws every 4 hours. Whenever changing the blade the teeth are swaged and sharpened. The blade is also thoroughly examined to see whether the blade has bent or deviated, and whether a bulge has occurred; such defects must be corrected immediately prior to sharpening.



Tensioning of circular saw blades
with a hammer and an anvil.

The edges of a circular saw blade are often burnt or overheated during operation, which results in bulges that will cause problems when sawing. This defect must be eliminated as soon as possible, by using a single-face hammer and an anvil.



Removal of bulges in a circular saw blade.

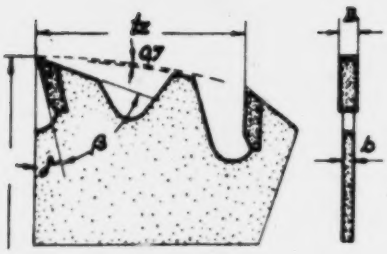
7. MAINTENANCE OF WIDIA (TUNGSTEN CARBIDE) CIRCULAR SAW BLADES

Circular saw blades with Widia (tungsten carbide) inserted tips are used for hardwood and boards in which a phenol-resin glue has been used. The maintenance of these blades is rather demanding due to the design of the tips of their teeth. Mechanical sharpening is the only acceptable procedure with these blades. The sharpening or grinding must be done on a regular basis to avoid damaged tips of the teeth caused by extreme stress during operation. Prior to sharpening the blades must be thoroughly cleaned to remove any resin, cellulose or similar stains. The blades are immersed into a chemical solution that will dissolve all such stains.

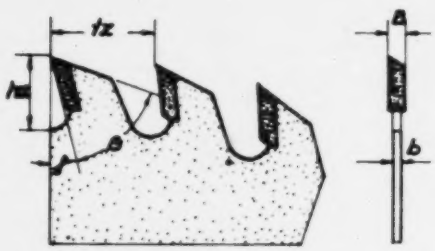
Machines of varying designs are used for sharpening - with diamond-impregnated grinding wheels - and this is entrusted to the most skilled workers. The progress made recently in this field is enormous: double-layer diamond impregnated grinding wheels with a large diameter are used; the grinding wheel oscillates during rotation, electronic probes are applied to examine the dullness of blades and to feed a computer with relevant data that will eventually operate the grinding machine and automatically monitor blade chip and grinding time, set geometrical data for

different blades, etc. Individual parameters, shape and dimensions of the blades must be fed into such a machine, which will all depend on their design, and specific materials they are used for. Such machines are still more the exception than the rule. Tungsten carbide-tipped cutting tools are sharpened using diamond wheels. When these become clogged up they are cleaned by applying cleansing liquids which are supplied by the producers of the wheels.

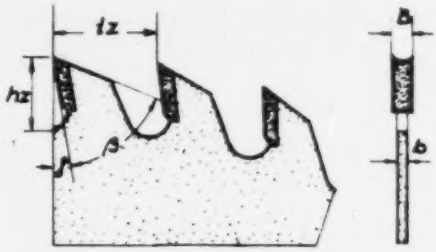
The following illustrates the shape of teeth in widia circular saw blades:



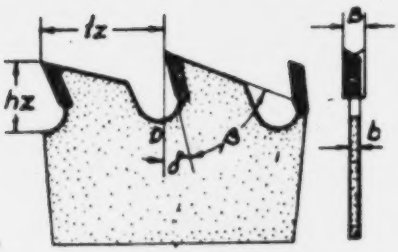
Tungsten carbide-tipped, and a safety device (0.7) that prevents backlash when solid wood is cut.



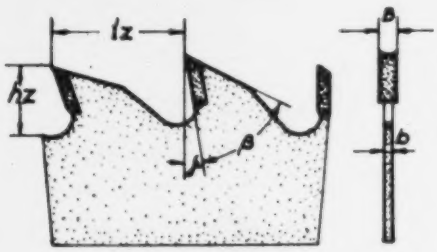
Circular saw teeth for size-cutting of particle and other boards; the right board edge is fine-cut.



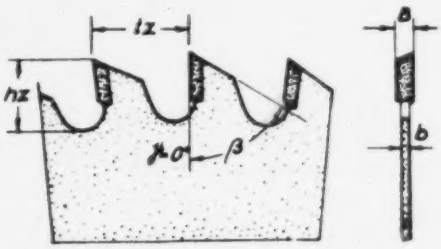
Circular saw teeth for veneered boards and fine cutting. The front end of teeth is sharpened to have a semi-circular shape.



Circular saw teeth geometry for solid-wood and boards; the back end of teeth is sharpened to have an oblique shape.



Circular saw blade for coarse cutting of solidwood and boards, with a very wide-pitch; the back end of teeth is sharpened to have an oblique shape. The blade is suited for manual feed.



Circular saw blade for size-cutting of particle and other boards; the left board edge is fine-cut.

8. BORERS AND MORTISING TOOLS FOR WOOD AND WOOD-BASED MATERIALS

Borers of varying design are used in woodworking. In all designs, however, the cutting edge suits the specific purpose for which the borer or mortising tool is used, e.g. for dowel boring, removal of knots, etc. The geometry, i.e. shape and dimensions, of cutting edges is adapted to the specific purpose, as indicated in the figures below:

For small-depth machine boring

For deep machine boring (e.g. 100 mm)

For manual boring

For deep manual boring

For hardwood machine boring

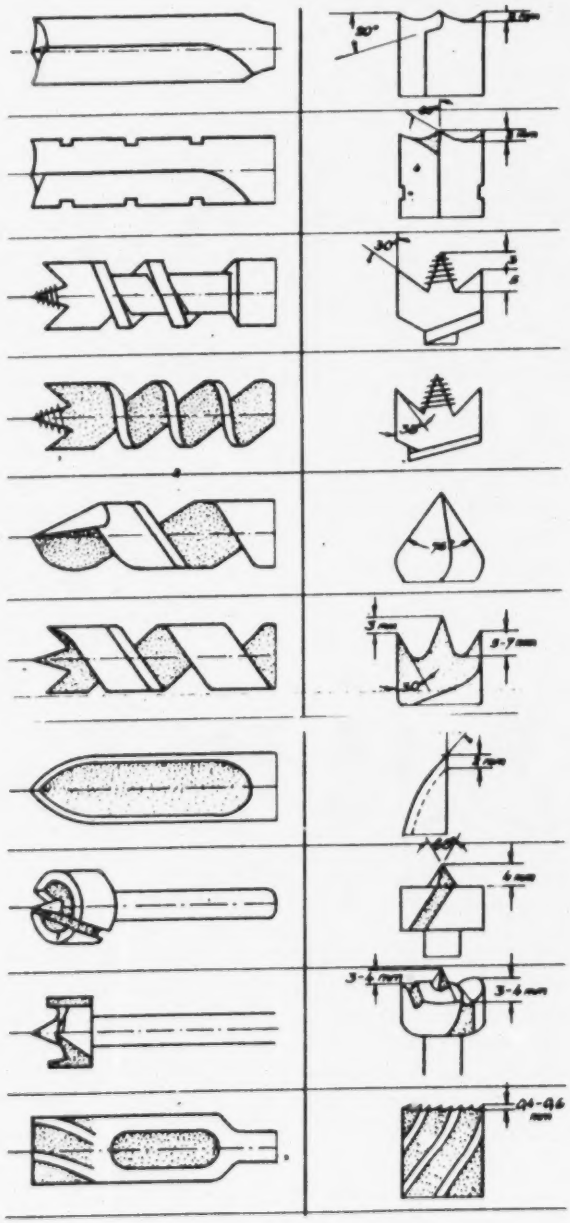
For hardwood and boards manual boring (manual dowelling)

For hardwood machine boring; bore-holes have a small diameter and depth

Mortising tool for knots

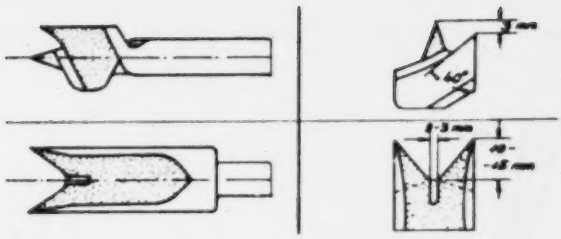
Borer for knots and holes needed for fittings

Mortising tool for plugging



Borer for manual insertion of fittings (bore-holes for locks)

Boring tool used in an automatic suspended borer

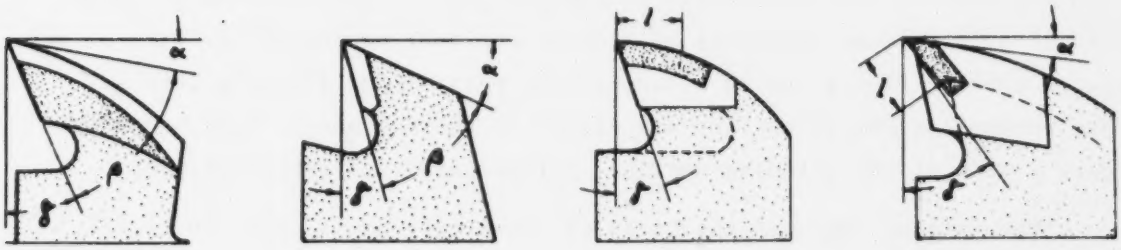


9. SHARPENING OF CUTTERS FOR WOOD AND WOOD-BASED MATERIALS

Cutters and borers are sharpened exclusively by sharpening and grinding machines, which assures that all cutting tips are equally distant from the centre-line of the tool. All cutting edges must be sharpened at the same angle. Mechanical sharpening of cutters and borers also assures a balanced tool since the chipped-off surface is equal in all cutting edges. The geometry of cutting edges is often determined by manufacturers of tools, but more often even by the users themselves. It is, therefore, indispensable to know under what conditions individual species and different wood-based materials should be cut. It is also necessary to know when to use cutting tools made of alloy steel and when those entirely made of Widia the strength of which is that of carbide boring tools - or when cutting tools should be used that are tipped with Widia plaquettes.

The sharpening of Widia-plated tools has already been described; sharpening rates and check-ups of tools may considerably reduce maintenance cost and boost the profitability of the tools.

C'assical shapes of cutting edges in cutting tools.



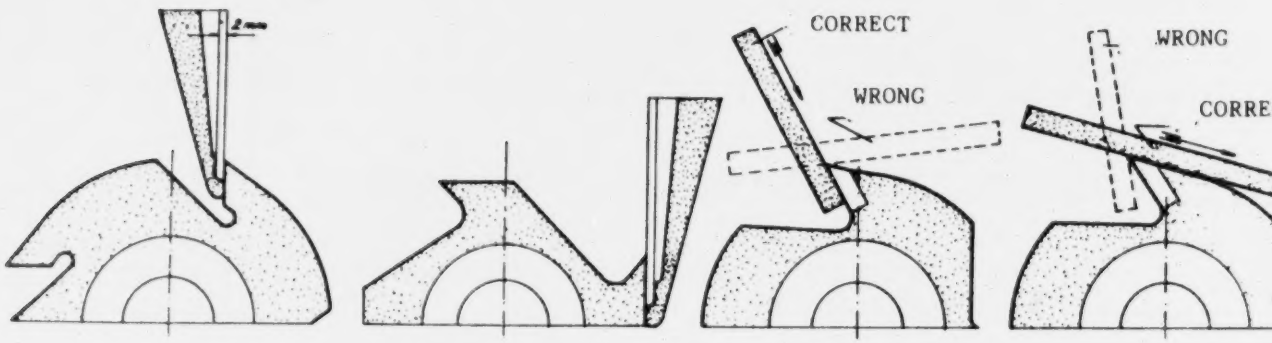
Solid (steel) cutter tooth.

Radially inserted tungsten carbide-tips.

Tangentially inserted tungsten carbide-tips.

Combined radially and tangentially inserted tungsten carbide-tips.

Fundamental cutting modes for cutting tools



Front bevel sharpening. | Back bevel sharpening. | Front bevel honing. | Back bevel honing.

10. KNIVES FOR THE CUTTING AND PEELING OF VENEER

A maintenance programme for knives used in the cutting and peeling of veneer includes the following stages: cleaning, sharpening and honing. Prior to sharpening veneer knives must be thoroughly cleaned with a solvent to remove stains on knives; often a cloth soaked in the solvent (a solution of oil and machine oil) will do.

The sharpening of veneer knives is done by a machine to which a tub is attached. The knife is clamped to machine gripping heads, either by means of screws or magnets. A sharpening tool moves along the knife; the tool is made up of segments or a large-diameter concave grinding wheel. A coolant must be fed permanently to the sharpened surface during grinding, and it will prevent excessive heating of the cutting edges. In view of the large coolant flow a tub is a constituent part of the grinding machine. Two hundred litres of coolant are stored in the tub and it must be changed once a week if the grinding machine operates under normal conditions.

The cutting angle of the knife is relatively small, i.e. 18 to 22°. In view of such a small angle a chipped surface develops during sharpening, which cannot be renewed automatically. Therefore manual devices are used

for this purpose, i.e. the best natural grinding stones. With such stones that are rinsed in caustic liquids the cutting edges of the knives can be formed in the best way.

11. CONCLUSIONS

Adequate maintenance of cutting tools used in a woodworking plant can be achieved only when a well-equipped sharpening and grinding workshop is available. It must be located in such a manner that the handling of the tools in the entire plant is as optimal and rational as possible.

Attention should be paid, furthermore, to machines and equipment of the workshop. It is recommended to use sharpening and grinding machines adjusted to specific tools and devices, and the sharpening programme should be changed as rarely as possible.

Qualifications and skills of workers employed in a sharpening and grinding workshop are extremely significant for a proper maintenance of cutting tools and devices, as well as viability of woodworking plants. The workers of such a workshop therefore must be highly skilled, and given access to further on-the-job training programmes.